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H3P PPTX
H3T T1P6 T2B3 T2B4
U1S S1175 S2280

(56) Documents Cited

GB 2255641 A	GB 2243217 A	GB 1576168 A
EP 0522598 A	WO 82/02536 A	US 4673827 A
US 4240528 A	US 3510677 A	

(58) Field of Search
UK CL (Edition M) G1N NDPM NDPQ NDPX
INT CL^5 H03K

(54) Capacitive proximity sensor

(57) A capacitive proximity sensing system comprises sets of electrodes 1, 2 coupled to frequency selective circuits 3, 4 (e.g. LC resonant circuits), circuits 5, 6 (e.g. oscillators) responsive to the characteristics of the frequency selective circuits, means 7 for comparing the outputs of circuits 5 and 6 and decision means 9 for providing an output from the result of the comparison. Arrangements are disclosed for making the system sensitive to the rate of change of capacitance of the electrodes, the approach or withdrawal of a body then being detected rather than merely its presence or absence.

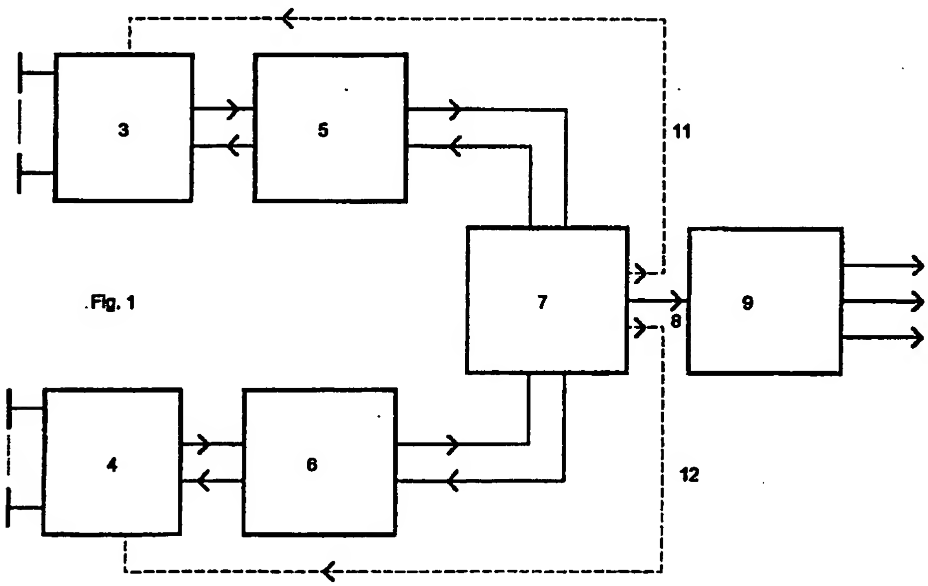

Fig. 1

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The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1990.

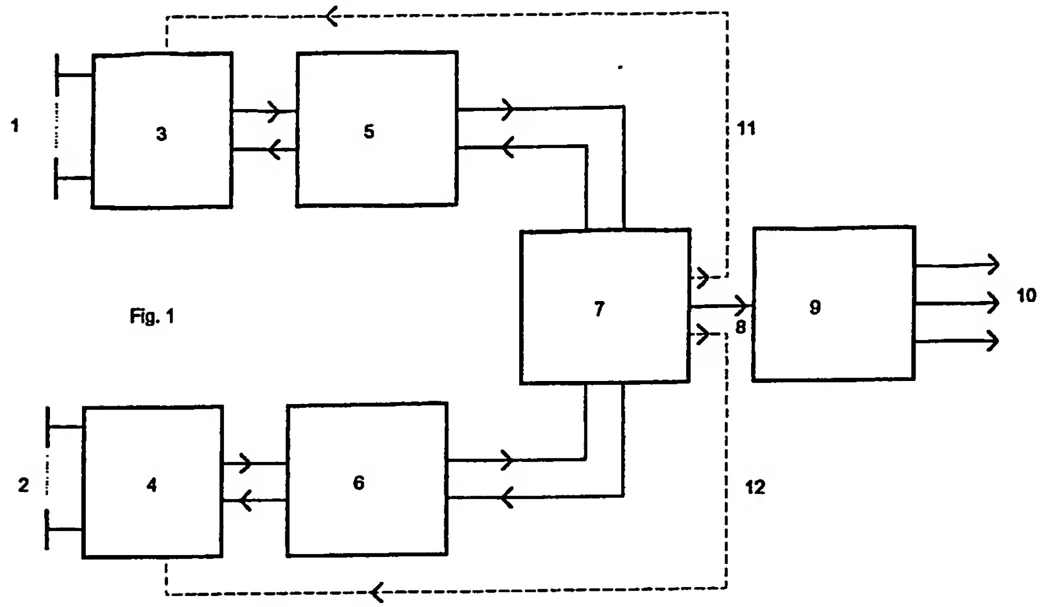


Fig. 1

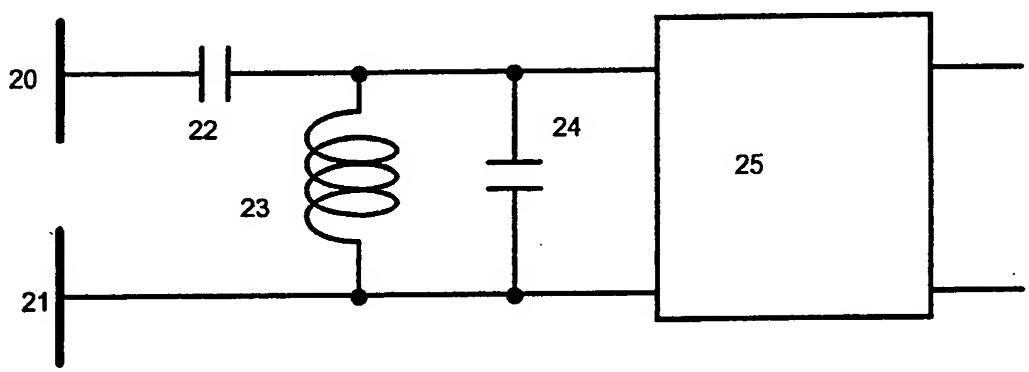


Fig. 2

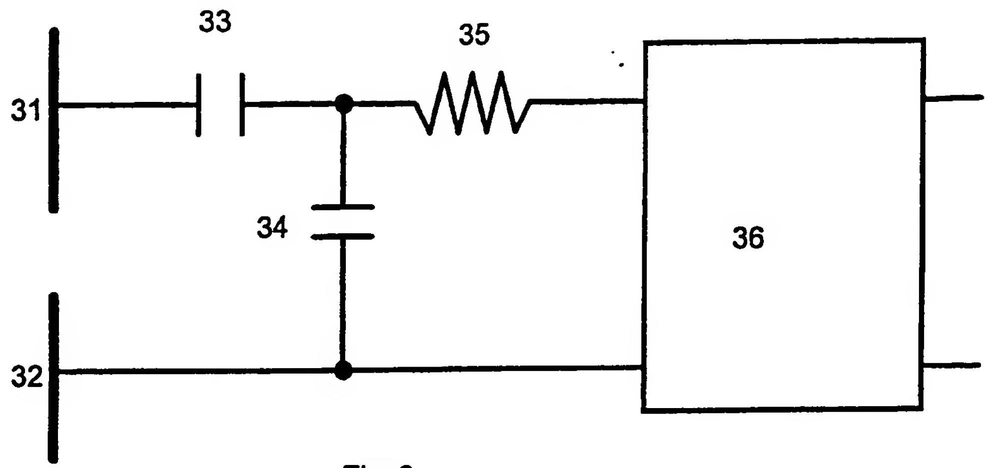


Fig. 3.

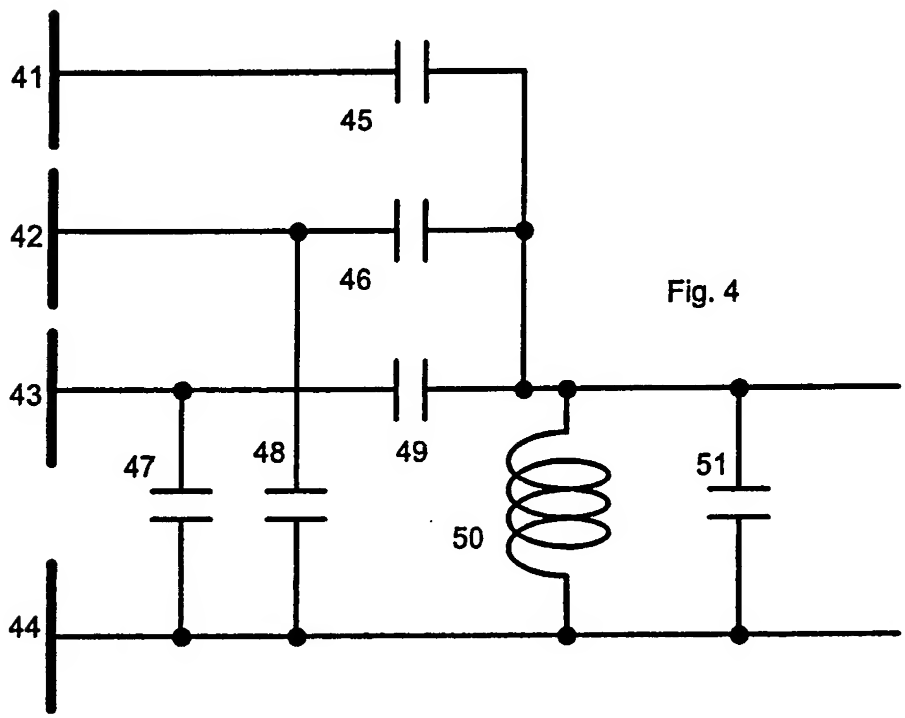


Fig. 4

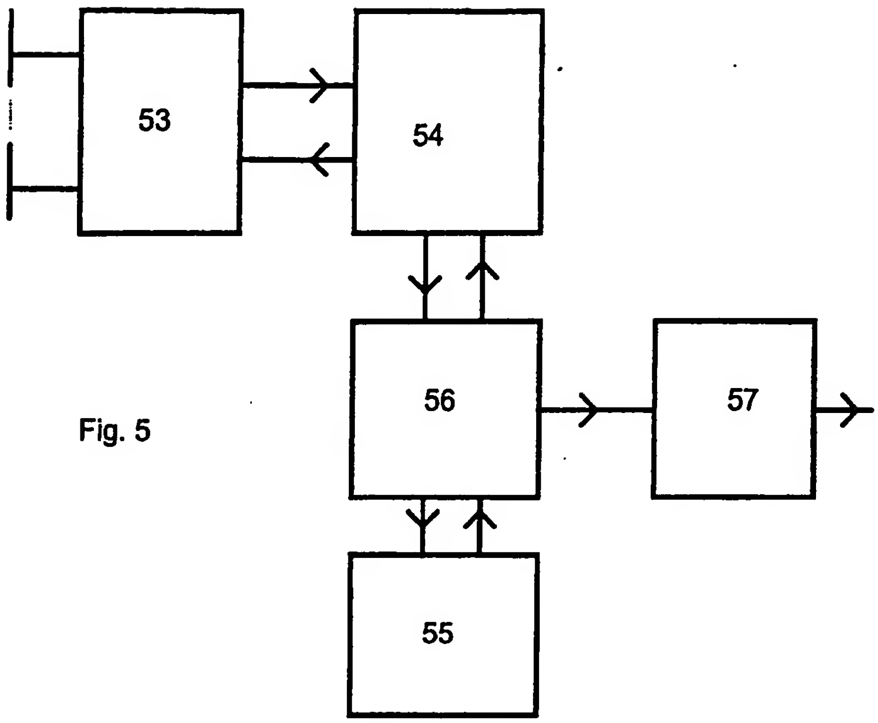


Fig. 5

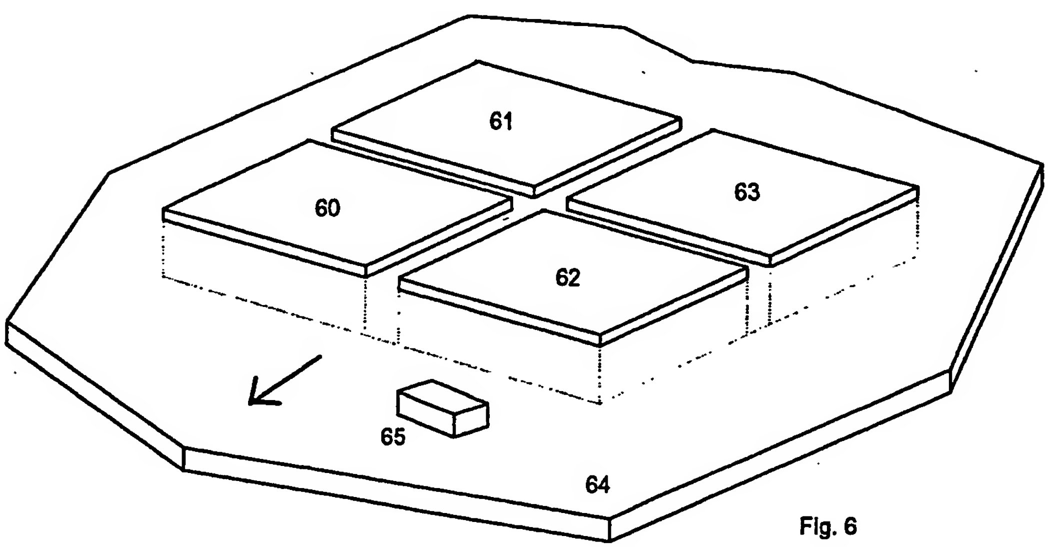


Fig. 6

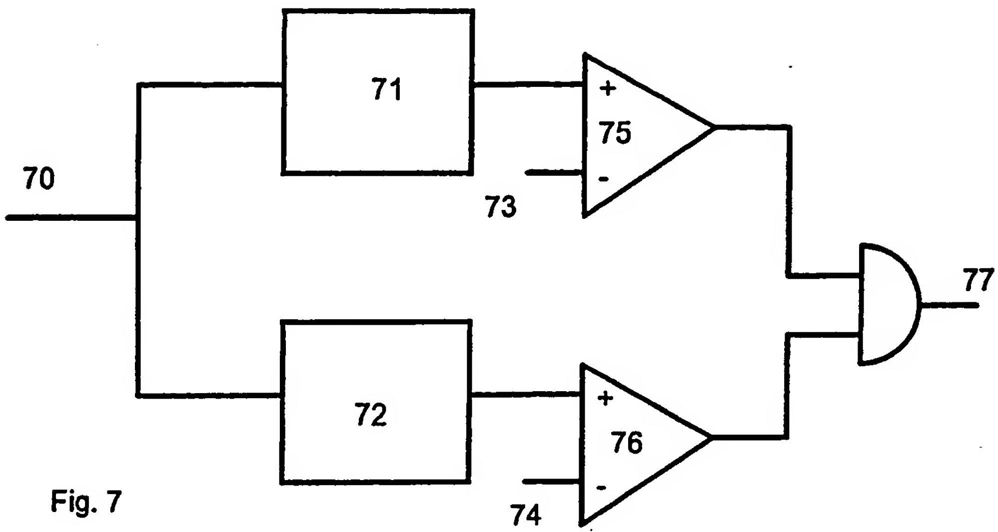


Fig. 7

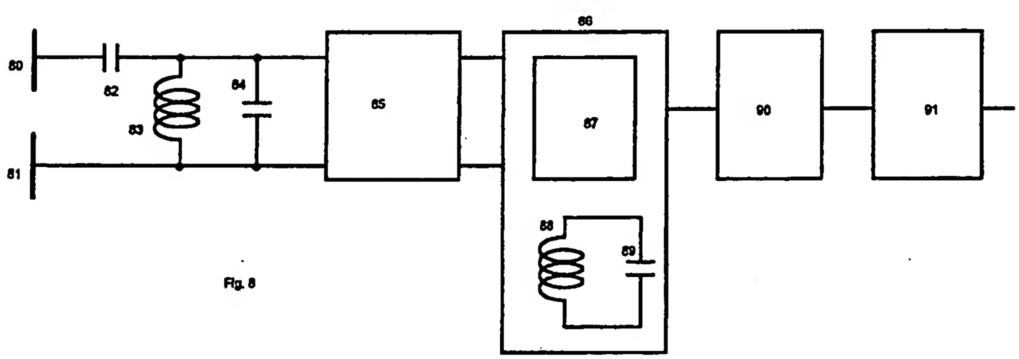


Fig. 8

Fig. 9

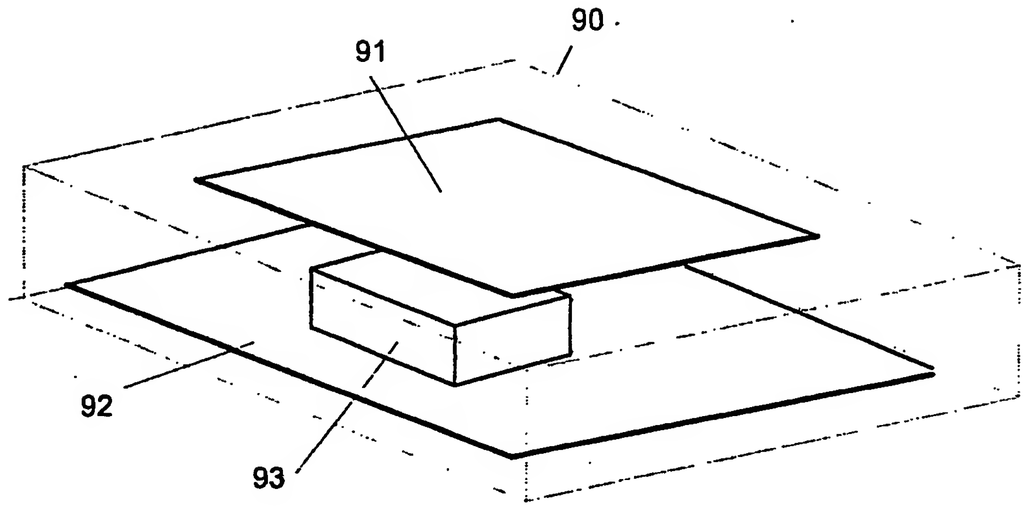


Fig. 10

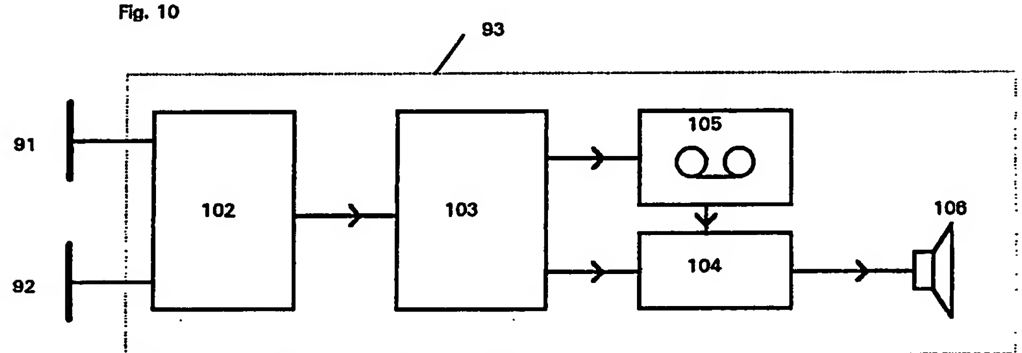
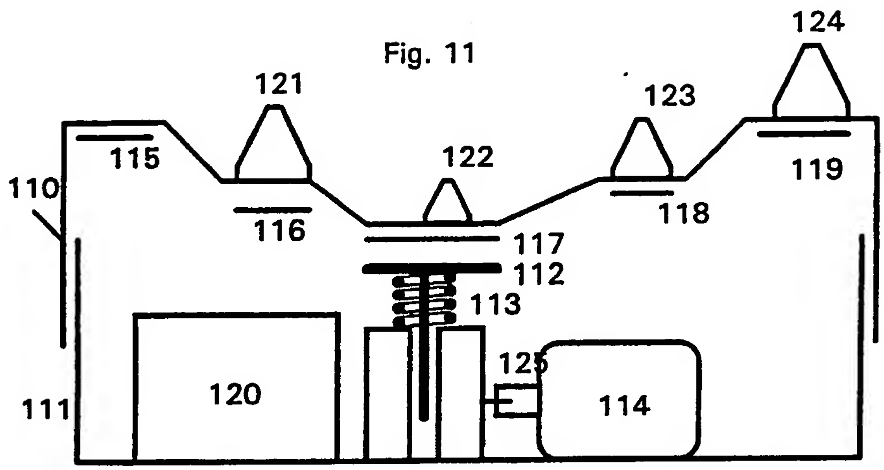


Fig. 11



Sensing Device

This invention relates to capacitive detectors.

There are many circumstances when it is desirable or necessary to detect the approach of an object in order to, for instance, initiate stop or prevent some action. In particular circumstances it is desirable to make such a detection in a battery powered device at very low cost and in a manner that is very insensitive to the exact physical environment in which the detector is placed. Existing detecting means, such as passive infra-red devices and capacitive switches, are not desirable under such circumstances due to their significant power consumption, cost or sensitivity to effects other than the motion to be detected. For example, existing capacitive switches operate at some predetermined level of capacitance which may occur simply due to a change in the environment in which the device is used, such as a change in humidity or condensed moisture.

This invention seeks to overcome these drawbacks of existing detection means using a capacitive technique that is insensitive to exact physical environment, has low power consumption, low cost and is sensitive only to the rate of change of capacitance due, for example, to a body approaching in close proximity to the sensor.

The applications to which this invention is ideally suited include any situation where power supply is limited (for example in small battery powered devices) and where the device needs to be in a sensitive state for long periods. Examples of this include, in a retail shopping environment, a device which can detect the occasional approach of a shopper to an item and initiate a spoken or visual message, a product demonstration or some other function. Such devices have been produced in the past but have limited usefulness due to their need to be connected to a mains power supply and because they are actuated by shoppers walking some distance away.

In other applications of this invention it is used to initiate some function based on the speed of approach of a part of the body, or some object in contact with a part of the body, where the speed of approach is used as an element of skill in the operation of some toy or game.

In yet other applications of this invention it may be used to replace a mechanically actuated electrical switch in various products, allowing them to be switched on or otherwise caused to operate by the user approaching them in close proximity. The very

low power consumption on the invention makes it feasible to eliminate a conventional switching means without significantly reducing the useful life of a battery power supply.

According to the present invention there is provided a sensing device comprising two or more frequency selective electronic circuits, one or more electrodes connected thereto, means for comparing the frequency characteristics of the frequency selective circuits and decision means for deriving one or more result signals from the output of the comparison means.

Specific embodiments of the invention will now be described by way discussion of the theory of its operation and of examples with reference to the accompanying diagrams in which:-

Fig. 1 is a diagram of the major functions within the generic sensing device

Fig. 2 is the an outline circuit for a possible embodiment of a frequency selective circuit

Fig. 3 is an outline circuit for an alternative embodiment of a frequency selective circuit

Fig. 4 is an outline circuit for a frequency selective circuit with connection to multiple electrodes with optional difference of sensitivity between the electrodes.

Fig. 5 is a diagram of the major functions within an embodiment having one set of sensing electrodes

Fig. 6 shows a possible arrangement of the electrodes of a sensing device where two sets of electrodes are used.

Fig. 7 shows the major elements within a possible embodiment of a decision circuit

Fig. 8 shows the major elements within a preferred embodiment of a sensing device

Fig. 9 shows the mechanical arrangement of an automatic message play unit

Fig. 10 shows the major functional elements within the apparatus shown in Fig. 9

Fig. 11 is a sectional view through a toy or novelty employing the sensing device to enable a skill game.

Refer to Fig. 1. Two frequency selective circuits 3 and 4 connect to respective sets of electrodes 1 and 2 so that frequency dependent characteristics of 3 and 4 are altered by the capacitances between the electrodes in the sets 1 and 2. Figs. 2 and 3 illustrate two preferred embodiments for circuits 3 and 4. Fig. 2 shows an inductor/capacitor resonant circuit coupled via capacitor 22 to electrode 20. Electrodes 20 and 21 are members of sets 1 or 2. Capacitance of electrode 20 to 21 and to other electrodes and to conductive bodies (such as the earth connection of mains electricity) affects the resonant frequency of the circuit. 25 is one of the process circuits 5 or 6. Capacitor 22 isolates the process circuit 25 from interfering signals (DC or low frequency) that may be coupled to electrode 20. Fig. 3 shows a alternative frequency selective circuit with a resistor 35 and capacitors in which the time constant is affected by the capacitance of electrode 31 to electrode 32 and other bodies. Fig. 4 shows multiple electrodes connected to a frequency selective circuit similar to that of Fig. 2. Electrodes 41, 42 and 43 connect to the inductor 50 of the resonant circuit by combinations of capacitors (45, 46 and 48, 47 and 49 respectively). By choosing the values of these capacitors alterations may be made to the relationship between changes of capacitance of the electrodes and the effect those changes have on the resonant circuit. For example, if capacitor 48 has a low value but capacitor 46 has a high value then changes in the capacitance of electrode 42 will strongly affect the resonant frequency. Conversely, if capacitor 47 has a high value but capacitor 49 has a low value then changes of capacitance of electrode 43 will have a weak effect on the resonant frequency. Capacitors such as 47 and 46 may be formed, in part, by the capacitance of the electrodes themselves. Likewise, series capacitors 45 and 48 may be formed from by the proximity of conducting bodies rather than as separate electronic components. In this way, the sensitivity of the frequency characteristics of the frequency selective circuit may be made high to the capacitance of some electrodes but low to the capacitance of others. Further, the sensing function may be physically extended through conducting bodies placed in proximity to the principal sensing electrode(s). These additional bodies need not be connected directly or through separate electronic components, they may be coupled through the inherent capacitance between them and the principal electrodes.

Process circuits 5 and 6 connect to circuits 3 and 4 and produce outputs that respond strongly to the frequency characteristics of circuits 3 and 4. For example, if the resonant circuit of Fig. 2 is used and an amplifier with feedback is built into the respective process circuit then an oscillator can be made whose oscillation frequency is the resonant frequency of the frequency selective circuit. In this way an oscillation may be produced whose frequency varies with the capacitance of connected electrode(s). With the circuit of Fig. 3, a process circuit may be connected that includes amplification and hysteresis

so that a relaxation oscillator is formed. A characteristic period of its oscillation will then change with changes in capacitance of connected electrode(s). Alternatively, the process circuit may apply a signal to the frequency selective circuit and a resulting signal is produced that varies with capacitance of connected electrode(s). For example, if an oscillation is applied, via an impedance, to the resonant circuit of Fig. 2 at a frequency close to the resonant frequency of the circuit then the amplitude and phase of the voltage across the inductor 23 will vary with the capacitance of connected electrode(s).

Sensing devices preferably have large but controllable sensing range. The electrode sets 1 and 2 are supplied with alternating voltages so that an alternating electric field is produced in their vicinity. Conductive or dielectric bodies entering this field affect the field so that the current from the electrode(s) that creates the field is affected. The capacitance of an electrode is this current normalised for voltage and frequency so the effect of a body entering the field is to affect the capacitance of the electrode(s). The change in capacitance as a body approaches the electrode(s) is dependent on the size and nature of the body and the size, shape and orientation of the electrode(s) and any other connected conductive bodies. It is desirable to create a large change in capacitance as a target body approaches so the effect of the body can be discriminated from that of thermal or other interfering variations in the sensing system. Electrodes are, therefore, preferably large and separated across the desired sensing volume. However, large electrodes are inconvenient in many applications of such a sensor so it is an objective to provide a sensing system that can reliably detect small changes in capacitance of the electrode(s). The geometry of the electrodes is preferably arranged to maximise the electric field strength in the desired sensing volume resulting from application of a given potential difference across the electrodes; This maximises the capacitance change resulting from a given disturbing body. When it is not possible to position electrodes in the optimum position on either side of the desired sensing volume then the electrodes should be shaped and positioned so as each to have comparable exposure in terms of projected area of the electrode to the volume and distance of the electrode from the volume. In some circumstances it may be desirable to forego this optimum configuration for other benefits. For example, if objects need to be placed in the sensing volume then in the optimum configuration these could cause excessive variation in the nominal capacitance between the electrodes. In these circumstances, it is preferable to devise an electrode structure (e.g. as in Fig. 9) such that objects may be placed so that the nominal capacitance is not strongly affected yet adequate change of capacitance occurs under typical desired sensing situations.

Small changes in capacitance will give only small changes in the frequency characteristics of the frequency selective circuits so means are provided to detect these preferentially and to avoid the effect of other variations due, for example, to thermal changes, local interfering electric fields, effects of changes in power supplies to the system etc. One method is illustrated in Fig. 5. Electrodes 52 are connected to a frequency selective circuit 53. Process circuit 54 supplies a signal to comparison means 56. A reference is supplied from circuit 55. Decision circuit 57 responds to the result from the comparison circuit to give a sensing result, typically a binary signal indicating the presence or approach of a body. The comparison means is highly sensitive to differences between the output from the process circuit and that from the reference so that small changes due to the approach of a body are accurately reflected in the output from the comparison means. The comparison could be of any signal characteristics that strongly vary with electrode capacitance. Supposing the process circuit 54 produces a varying frequency signal then the reference could give a fixed frequency signal and the comparison means would then produce the difference (or "beat") frequency. The decision circuit would then be responsive to this difference frequency. Alternatively, a varying frequency signal from the process circuit could be applied, through the comparison means, to a frequency selective circuit in the reference circuit 55. The reference circuit would then return a signal of variable phase and/or amplitude to the comparison means, the output of the comparison means then being responsive to phase and/or amplitude of the signal from the process circuit 54 relative to that from the reference circuit 55.

If the reference has fixed characteristics then the system will be sensitive to variations in the frequency selective circuit 53 or the process circuit 54 that are not caused by the presence of bodies. Disturbances due to thermal effects, ageing, changes in supply power etc. may cause unreliable operation when large sensing range is attempted. If, however, the reference circuit is made in a similar way and from similar components to those in the circuits 53 and 54 then they may be expected to vary in similar ways to such disturbances, so that their effects will be nulled by the comparison means. Referring to Fig. 1, this nulling principle may be extended to disturbances in the locality of the electrodes. Similar electrode sets, frequency selective and process circuits (1+3+5, 2+4+6) provide signals to the comparison means 7. The comparison result will then respond to effects on one electrode set that is different to the effect on the other set. For example, Fig 6 shows an array of electrodes (60 to 63) moving in the direction of the arrow across a plane 64. electrodes 60 and 61 would form one set (e.g. 1 of Fig. 1) and 62 and 63 would form the other set (e.g. 2 of Fig. 1). The height of the electrodes above the plane could have a very strong effect on the capacitance of the electrodes.

However, since the sensing system compares the outputs from the two sets, this effect is nulled, allowing the system to detect small objects such as 65.

In Fig. 5 The decision circuit 57 may simply be sensitive to a difference value above (or below) a pre-set value. In this instance the system would be sensitive to the presence of a body. Alternatively, the decision circuit may derive the time variation of the comparison result so the sensing result could be related to the rate of change of capacitance of the electrode(s). In this case the system would respond to the approach and/or withdrawal of a body, rather than the mere presence. This is advantageous in some uses where the immediate environment of the electrodes is not predictable. Using this technique, the presence of fixed bodies would be nulled after an initial stabilising period so that the approach of other bodies can be determined largely independent of the presence of other, fixed bodies. This technique also reduces the effect of variation of the sensing circuits since slow changes due, for example, to temperature changes are largely removed by the rate-dependent circuit.

If the environment local to the electrode(s) can vary greatly then the corresponding range of capacitance of the electrodes may be wider than that conveniently covered by the process circuits or comparison means. A means to overcome this is to use a feedback signal (e.g. 11 and/or 12 in Fig. 1) from the comparison means to correct for environmental changes to the sensing system. Such a signal would be filtered so that it varied only slowly and faster changes due to the approach or withdrawal of bodies would still be detected. Typically the signal(s) would be used to adjust the capacitance of variable capacitance diode(s) built into the frequency selective circuits so as to counteract the effect of capacitance changes due to changes in environment local to the electrode(s).

The decision circuit can be made sensitive to combinations of effects. For example, Fig. 7 shows a decision circuit that only gives a detection output when there was a fast change of capacitance at the same time as a large change. The output from the comparison means is applied to two signal paths. In the first, the signal is differentiated by 71 and compared to a fixed reference value 73 by comparator 75. In the second path, the signal is filtered by high pass filter 72 and the result is compared to another fixed reference 74 by comparator 76. Gate 77 performs the logical AND yielding a detection result only when both paths give a positive indication. The first path detects fast changes while the second path detects large changes. Other detection combinations would be possible depending on the filtering, comparison and logical combination employed.

The above techniques may be used in embodiments suited to a wide range of applications. Power consumption is a characteristic important to a number of sensing applications that must operate for long periods from batteries. In this instance a preferable embodiment is illustrated in Fig. 8. The capacitance of electrodes 80 and 81 affect the resonant frequency of the tuned circuit including inductor 83. Single transistor oscillator 85 sends a signal, whose frequency varies with the capacitance of the electrodes, to comparison means 87. A second frequency selective circuit (88 and 89) acts as a reference. 88 and 89 work with the comparison means to act as a frequency discriminator 86 (such as quadrature or ratio detectors used in FM radio receivers) to give an output signal whose voltage is related to the difference in frequency of the oscillator from that of the resonant frequency of the reference tuned circuit. High pass filter 90 extracts changes in the output of the discriminator 86 and threshold circuit 91 gives a binary detection signal if the change is large enough. An increase in capacitance of the electrodes would give a detection output so this system would be arranged to detect the approach of bodies. The addition of a second threshold circuit, sensitive to negative outputs from the filter 90 could detect the withdrawal of bodies.

Preferably, an embodiment should not cause interference to other electronic apparatus nor should it be sensitive to interfering fields. A nominal oscillation frequency in the range from about 50kHz to 1MHz is suitable to achieve this but other frequencies are possible. Within this approximate range, strong interfering fields are rare in typical environments. Also, oscillation voltages applied to the electrodes (typically in the range 0.5-10V) do not radiate substantial energy provided the electrodes are not large, for example less than 1 metre in any dimension.

Within the above frequency and voltage range it is simple to devise a tuned LC oscillator that operates with low power consumption. The frequency discriminator is typical of those used in FM receivers and again can be implemented to operate with low power consumption. Following the discriminator the bandwidth is preferable restricted to reduce the effect of received interference and other noise sources. A bandwidth limited to a maximum of 10Hz strongly reduces noise effects, including microphonic pickup, yet maintains sensitivity to typical hand movements that it is desirable to detect. When operating with such low frequencies, circuits for the decision circuit may easily be implemented with low power consumption.

Other apparatus may be combined with the sensor to yield practically useful results. For example, such a sensor could be built into an electronic toy so that it activated when approached or handled by a child. A timing device or manual operation would be used

to return the product to the dormant state. Low power consumption is important as the toy preferably may be left dormant for months without significant battery consumption.

Other products may incorporate such a sensor to perform sensing functions intrinsic to the operation of the product as well as optionally activating the product from its dormant state. A toy could for instance, use the sensor to activate then the product makes responses to the child (by sound, lights, pictures etc.) whenever the sensor is reactivated. If activations cease for a pre-set period then different response(s) may be made.

The sensor also enables certain device in their entirety. Fig. 9 shows a first example. Box 90 (shown dotted for clarity) encloses two sensor electrodes 91, 92 and an electronic apparatus 93. Fig. 10 is the block diagram of the apparatus. Electrodes 91 and 92 connect to sensor circuit 103, an embodiment of the sensor described previously. The sensor is arranged to give a positive result when a body approaches the electrodes. Control circuit 104 is activate by the positive result from the sensor and causes message store unit 105 to replay a pre-recorded message. The message store may use conventional magnetic media or electronic means for storage. The message is played through loudspeaker 107 via amplifier 106.

Such a device may be used in retail outlets or other public places to give information. A piece of merchandise, a leaflet dispenser, or other items may be placed on or near the device; anyone who shows specific interest in the items by touching or approaching closely will trigger the device and cause the message to be played. The message is not limited to solely speech since music or even visual replay is possible. Further, it is possible to trigger an animated display or even to activate the merchandise on display.

Fig. 11 shows sectional view through a toy or novelty that relies on the sensor. The mechanism of the toy is enclosed between the lid 110 and the base 111. The lid may be pushed down relative to the base, compressing spring 113 via plunger 112. A latch (not shown) locks the spring in a compressed state until solenoid 114 is activated whereupon its plunger 125 releases the latch and the spring pushes up the lid at speed. Beneath the lid 110 are sensor electrodes 115-119. Some of these connect to sensor electronics which activates the solenoid in response to increases in capacitance of the connected electrodes. Other electrodes of the set 115-119 may couple to the connected electrodes through the inherent capacitance between them. As part of a game, playing pieces are placed or thrown onto the lid. They may land in different orientations and in different places on the lid. An objective could be to remove as many pieces as possible without triggering

the sensor. Should the sensor be triggered then the remaining pieces are thrown in the air and the game is over.

The decision circuit in the sensor is arranged to be principally sensitive to rate of increase of capacitance of the electrodes. It may be further enhanced by having a variable threshold of sensitivity; the threshold may adjusted manually (e.g. as a switch between "easy" or "hard") or automatically, with time (e.g. so it becomes increasingly difficult to remove without triggering as the game progresses) or some other variable.

Optionally, the pieces may be made of different sizes or materials so that some are more difficult to remove without triggering than others, so commanding a higher score. Pieces that are low in height or are difficult to grip will be more difficult to remove since the player's fingers will have to approach the electrodes more closely. As this happens, the change in capacitance of the electrodes increases for a given amount of movement. If a piece is made of conductive material then it is also difficult to remove without triggering since the piece will act to extend the electric field from the electrodes beneath the lid.

Areas of the playing surface on the lid may be made to have different sensitivities, again so that they command different scores for pieces removed from them. This may be achieved by altering the electrical coupling to respective electrodes in the way illustrated in Fig. 4. Alternatively, the spacing between the respective electrode and the top surface of the lid may be altered. Electrode 116 is spaced further than is electrode 118 so it would be more difficult to remove a piece (without triggering) from above 118 than from above 116. This alteration of spacing may be through multiple electrodes spaced at the necessary distances from the top of the playing surface or may be done with a single, shaped or plane electrode in combination with a shaped or plane lid.

In the game described, it is the objective to remove pieces without triggering the sensor. The sensor responds to an increase in electrode capacitance as an approach to remove a piece. If the player can approach sufficiently slowly to avoid triggering then he may remove the piece as quickly as he likes since this causes a decrease in capacitance so would not cause triggering. The decrease in capacitance may be used to add an automatic scoring feature. If the electronic system detects the decrease in capacitance then measures the peak rate of reduction of capacitance and the actual decrease of capacitance during the detection of removal then this can be used to accumulate a score. A fast removal of a "difficult" piece (i.e. one whose characteristics and location would cause a large increase in capacitance on approaching it) would give a large reduction of capacitance and large rate of reduction, so would score highly.

Claims

1. A sensing system comprising spaced electrodes electrically coupled to frequency selective circuits, process circuits electrically coupled to the frequency selective circuits, comparison means electrically coupled to the process circuits and decision means electrically coupled to the comparison means wherein the decision means produces a sensing result.

2. A sensing system as claimed in claim 1 wherein the electrodes are in two sets, each electrode set is electrically coupled individually to a frequency selective circuit and each frequency selective circuit is electrically coupled individually to a process circuit.

3. A sensing system as claimed in claim 1 or claim 2 wherein the frequency selective circuits include inductive and capacitive elements.

4. A sensing system as claimed in claim 1 or claim 2 wherein the frequency selective circuits include resistive and capacitive elements.

5. A sensing system as claimed in any of claims 1 to 4 wherein one process circuit is adapted to cooperate with a coupled frequency selective circuit as an oscillator.

6. A sensing system as claimed in any of claims 1 to 4 wherein two or more process circuits are adapted to cooperate with coupled frequency selective circuits as oscillators.

7. A sensing system as claimed in claim 5 wherein one process circuit coupled with a frequency selective circuit and a comparison means cooperate as a detector of frequency modulation.

8. A sensing system as claimed in claim 6 wherein the comparison means is a beat frequency detector.

9. A sensing system as claimed in any of claims 1 to 8 wherein comparison means includes a wave filter with low frequency pass characteristic.

10. A sensing system as claimed in any of claims 1 to 9 wherein a multiplicity of the electrodes are coupled to the frequency selective circuits by impedances adapted to predetermine the sensing characteristic of individual electrodes.

11. A sensing system as claimed in any of claims 1 to 10 wherein one electrode comprises the sensing system exclusive of other electrodes, power source and electrically coupled elements other than those of claim 1 .

12. A sensing system as claimed in any of claims 1 to 11 wherein electrical coupling from the comparison means to one or more frequency selective circuits is adapted to stabilise the operating point of the sensing system wherein the coupling optionally includes a wave filter with low pass or integration with time characteristic.

13. A sensing system as claimed in any of claims 1 to 12 wherein the decision means includes one or more wave filters and one or more signal threshold comparison circuits.

14. A sensing system as claimed in claim 13 wherein one or more of the wave filters has a high frequency pass or differentiation with time characteristic.

15. A sensing system as claimed in any of claims 13 or 14 wherein the threshold value is adapted to change according to a manually adjusted signal or an automatically varying signal or an externally applied signal.

16. A sensing system as claimed in any of claims 13 to 15 wherein a sensing result is a logical combination of the outputs of the signal threshold comparison circuits.

17. A sensing system as claimed in any of claims 13 to 16 wherein one or more of the signal threshold comparison circuits are responsive to the sign of the output from one or more of the wave filters within the decision means.

18. A sensing system as claimed in any of claims 13 to 17 wherein one or more of the signal threshold comparison circuits are adapted to provide a sensing result of variable magnitude responsive to the magnitude of the output of one or more of the wave filters within the decision means.

19. A sensing system as claimed in any of claims 1 to 18 in combination with an additional system wherein the sensing result of the sensing system activates the additional system from a dormant to an active state.

20. A toy, game or novelty including a sensing system as claimed in any of claims 1 to 19 wherein the objective is to remove, move or place objects from or near the sensing system without causing a change in a sensing result from the sensing system.

21. An information or entertainment system or toy or novelty incorporating a sensing system as claimed in any of claims 1 to 19 wherein the sensing result from the sensing system causes playback of a pre-recorded message.

22. A sensing system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

Patents Act 1977
Examiner's report to the Comp[redacted]ler under Section 17
(The Search report)

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Applica[redacted] number
GB 931[redacted].0

Relevant Technical Fields

(i) UK Cl (Ed.M) GIN NDPQ, NDPX, NDPM

(ii) Int Cl (Ed.5) HOEK

Search Examiner
A J OLDERSHAW

Date of completion of Search
14 SEPTEMBER 1994

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1-22

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2255641 A	(TSUDEN)	1 at least
X	GB 2243217 A	(FORMULA SYSTEMS)	1 at least
X	GB 1575168	(MITSUBISHI)	1 at least
X	EP 0522598	(MASCHINENFABRIK)	1 at least
X	WO 82/02536	(PAYNE)	1 at least
X	US 4673827	(GEBHARD BAULUFF)	1 at least
X	US 4240528	(MASCHINENFABRIK)	1 at least
X	US 3510677	(LISTER)	1 at least

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